

CHAPTER 3 – RESEARCH METHODOLOGY

Research methodology refers to the systematic and structured process followed by researchers to conduct a study or investigation, gather data, analyse it, and draw valid conclusions based on evidence. It encompasses the strategies, techniques, tools, and procedures used to answer research questions and achieve research objectives (Kayaduman et al., 2021). There is various methodology in quality management and process improvement such as PDCA and DMAIC, DMAIC represents a comprehensive problem-solving approach that underscores the importance of collaboration and communication at every stage of the process. It integrates elements from PDCA into its structure while incorporating additional techniques like brainstorming and team building. The DMAIC framework serves as a systematic method to improve project efficiency, pinpoint areas for enhancement, analyse root causes, create and execute solutions, and assess overall performance. This chapter employs the DMAIC method as the chosen methodology, Figure 7 shows its flowchart.

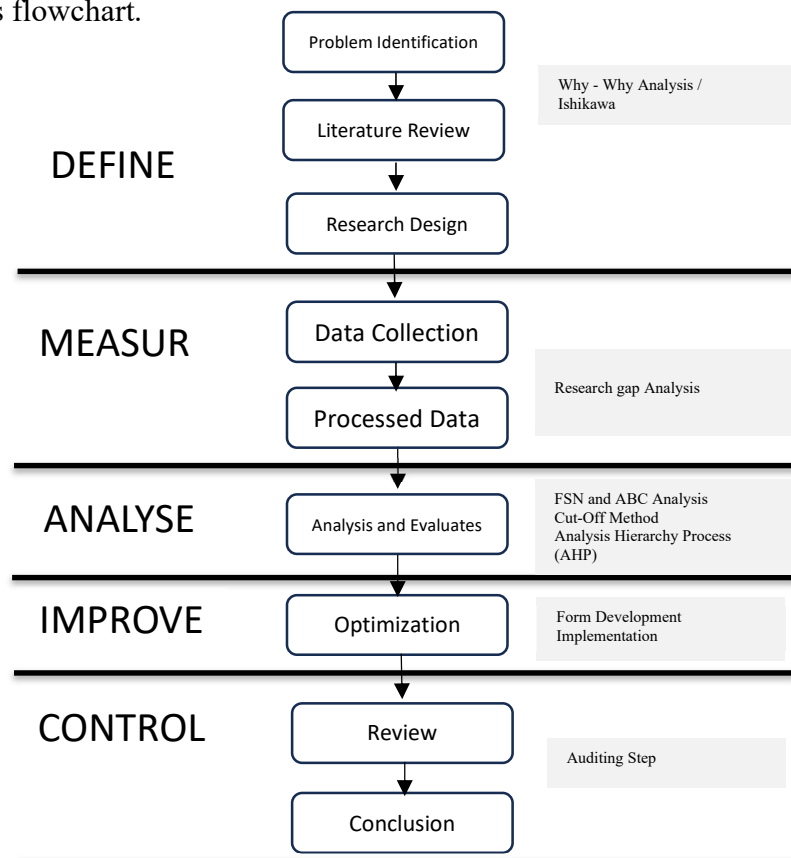


Figure 7. Research Methodology

3.1 Define

3.1.1 Problem Identification & Objective

Problem identification is the initial phase in research, it helps to understand the problems that need to be solved, and the topic of relevance to be researched. The goal is to gain a clear and thorough understanding of the problem to be studied so that we can formulate appropriate and relevant research questions and what factors are affecting the main problem.

3.1.2 Literature Review

A comprehensive review of existing studies or research such as journal, papers, books, articles, etc. to support the research idea, such as decision frameworks, methodology, highlight key finding, theories and concept of critical spare part management. The relationship between critical spare parts management and inventories management needs to be considered and also the most optimum decision on spare parts management.

3.2 Measure

3.2.1 Data Collection

To address the research problem, it is necessary to collect data through a combination of qualitative and quantitative methods, here's a breakdown of data collection needs:

1. Research gap by literature review, review existing literature on spare parts management, optimization models, and relevant industrial practices. Identify commonly used criteria for defining critical spare parts and methods for determining optimum stock levels.
2. Expert Interviews, surveys and Questionnaires, develop surveys/questionnaires for professionals in the field to gather quantitative data. Include questions about criteria for critical spare parts and methods for determining optimum stock levels.
3. Data from Maintenance Records, analyse historical maintenance records to identify instances where spare parts were critical for minimizing downtime or preventing major failures. Extract information on the types of spare parts that were critical in different situations. Collect historical critical spare parts inventory data in Air

Compressor Unit System, maintenance records, lead times, demand patterns, and failure rates from relevant maintenance systems or databases.

4. By combining information from these various sources, we can develop a comprehensive understanding of the criteria for critical spare parts and effective methods for optimizing stock levels.

3.3 Analyse

3.3.1 Data Analysis

Develop an analysis framework for critical maintenance spare parts inventory. This might involve identifying critical parts, failure modes, consequences of stockouts, and other relevant risk factors. Assign risk scores to each part based on their criticality and potential impact on operations based on failure mode and effect analysis method (FMEA). Historical consumption of spare parts also can be utilized to analyse optimum stock. Current various criteria decision-making during stocking spares item could be obtain from the result of interviewing in charge person on stocking decision making.

3.4 Improve

3.4.1 Project Time Line

Table 2 shows the period that required in this study is 3.5 months. The research project design was carried out in 3rd week of September 2023 and then continued with research trough gap analysis and collecting data. Then in November, start to have focus group discussion, and assessment. Next in December in 2023, this research conduct develops for modelling and procedure for new stocking policy.

Table 2. Project Time Line

No	Activities	Week															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Problem Identification	■															
2	Research Design and Methodology		■														
3	Data Collection			■	■	■											
4	Data Analysis, Assessment					■	■	■	■								
5	Develop /Deploy Improvement / Validation									■	■	■	■				
6	Discussion Result and Analysis													■	■		
7	Conclusion and Recommendation															■	■

3.4.2 Optimization Method

Create an optimization method that incorporates the risk assessment results. This method should consider factors such as risk scores, demand variability, lead times, and costs associated with stockouts and excess inventory through Multicriteria Analysis Decision approach.

3.5 Control

3.5.1 Review Implementation

Validate the optimization method using real data or hypothetical scenarios. Compare the results to demonstrate its effectiveness.

3.5.2 Analysis and Evaluation

Analyse the research findings and evaluates the implications of method approach on maintenance operations, cost savings, and overall inventory performance.

3.5.3 Conclusion

Summarize the key findings, restate the significance of the research, and provide practical recommendations for organizations to adopt methodology approach in optimizing maintenance spare parts management.